Town of New Shoreham
Broadband Plan and Network Designs
January 2015

Report prepared by:

On behalf of:

EA Engineering, Science, and Technology, Inc.

BBRI is a project of the Rhode Island Department of Administration Office of Digital Excellence in partnership with Rhode Island Commerce Corporation and is funded by the US Department of Commerce National Telecommunications and Information Administration (NTIA)

For Further Information Contact:

Stuart Freiman
Broadband Program Director
RI Office of Digital Excellence
sfreiman@commerceri.com
401-278-9168

http://broadband.ri.gov

TILSON

245 Commercial Street
Portland, ME 04101
Phone: 207-591-6427
E-mail: info@tilsontech.com

Note

Cost information included in the following report is an estimate based on recent quotes, historical data, certain assumptions about the project scope and approach, the regulatory environment and market conditions at a fixed point in time. Given these variables, we recommend updating the estimate as time passes, and allocating sufficient contingency to allow for inevitable but unpredictable changes in the cost environment if the project moves forward.

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Executive Summary

Broadband Rhode Island (BBRI), part of the Rhode Island Office of Digital Excellence (ODE) has engaged EA Engineering Sciences to perform data collection and broadband mapping for the State Broadband Initiative (SBI), a federally-funded NTIA grant. For this project, an extension of the SBI, EA Engineering, Science & Technology, Inc. engaged Tilson to address a broadband service gap in The Town of New Shoreham (Block Island).

Specifically, Tilson was asked to assess the state of telecommunications infrastructure on the island, articulate the community's standard for broadband service, analyze the gap, and design solutions for closing that gap.

Block Island's telecommunications infrastructure is very limited in comparison to mainland Rhode Island, Connecticut, New York, and Massachusetts. There are two communications towers on the island capable of providing cellular service. Verizon provides phone service and basic DSL (digital subscriber line) internet over twisted pair copper wire. The DSL service fails to meet many of the needs of residents and businesses. Alternative internet service can be purchased via satellite subscriptions. The former Block Island Cable Company used to provide cable television services but has been shut down for several years without another provider filling the gap. Unlike other offshore island communities such as Martha's Vineyard and Nantucket, Block Island does not have a physical telecommunications connection to the mainland. All of the island's broadband utilizes wireless microwave signals for backhaul.[1] Furthermore, the age and condition of the copper plant likely hinders broadband performance.

Many rural communities in North America lack last mile residential broadband coverage. Block Island also lacks the middle mile infrastructure that can connect these facilities to the internet backbone on the mainland. Recent developments will likely change this status quo. The Town currently has an opportunity to lease eight strands of fiber from the National Grid cable running to a proposed offshore wind farm. Assuming these negotiations are successful, this fiber has the potential to provide exactly the middle mile infrastructure necessary to serve homes and businesses. Should these negotiations not succeed, or should the fiber not be built, the Town can secure sufficient backhaul through wireless technology at a fraction of the cost of submarine fiber, but at reduced bandwidth and some sacrifice of reliability.

With this new fiber optic infrastructure in hand, the Town aspires to ensure that all of its residents and businesses have access to 30 mbps symmetrical service, or better. Fiber optics or 4G LTE wireless are the two telecommunications technology that can meet and surpass this threshold. Tilson designed two high level networks that provide this service. Under option one, a fiber optic network is built throughout the Town to every home on the island and mounting equipment on existing utility poles. Tilson estimates the cost of constructing this network to be $4.3 million. Under option two, fiber is run along the major roads in town to connect new cellular antennas that provide a wireless last mile product to homes and businesses equipped with antennas and modems. This project is significantly less expensive than the fiber option at $1.4 million. However, it offers tradeoffs. Cellular broadband tends to experience lower

[1] Backhaul is a telecommunications term referring to the connection between a small network, like Block Island's, and the worldwide web.

signal quality than fiber optic broadband and the implementation of this solution will require the construction of four cell towers on the island. Tilson also considered the possibility of partnering with a cable company to provide service on the island, utilizing the Town's leased fiber for backhaul.

Tilson identified six potential models for operating a new residential and business network. The feasibility of these options partial depend on any restrictions placed on the use of the National Grid fiber. However, any restrictions can be circumvented through redundant microwave connections to the mainland. These business models represent a range of options for balancing the community's preference for network control and risk tolerance. Potential structures for building, owning, and operating a new network include attracting a private carrier to provide service at no cost to the Town, subsidizing the incumbent carrier (Verizon) to build fiber to the premise (FTTP) connectivity, forming a new corporate entity, forming a town utility, building the network as a public asset, and building the network as a public asset but leasing it to a third party. New Shoreham's current poor service offerings may make the town eligible for Universal Service Fund subsidy. Towns in the U.S. with service under the 4 mbps download/ 1 mbps upload threshold that the FCC defines as broadband, can apply for federal funding for network improvements. Usually these applications are done through the incumbent service provider, i.e. Verizon.

The Block Island Community has a number of options available for cost effectively improving its broadband situation. The FTTP solution can provide world class internet access for a generation. The wireless option can cost effectively meet the community's broadband needs in the near term and improve cellular service on the island at same time.

Defining Broadband

It is important to note that the term “broadband” does not refer to any technology in particular. Rather it refers to data transmission through a medium in excess of certain threshold. From an information technology perspective, it represents the amount of data that a consumer can download or upload from the internet in a given second. This is the measurement known as bandwidth. Greater bandwidth is analogous to a faster connection. Connection speeds are generally measured in kilobits per second (Kbps), megabits per second (Mbps) or gigabits per second (Gbps).[2]

In the U.S., broadband standards are defined by the Federal Communications Commission (FCC), which regulates interstate and international communications by radio, television, wire, satellite and cable. The FCC uses a tiered approach to define broadband based on download and upload speeds for wireline and wireless technologies:

FCC Speed Tier	Download Speeds	Upload Speeds
1st Generation Data	200 Kbps to 768 Kbps	200 Kbps to 768 Kbps
Tier 1	768 Kbps to 1.5 Mbps	768 Kbps to 1.5 Mbps
Tier 2	1.5 Mbps to 3 Mbps	1.5 Mbps to 3 Mbps
Tier 3	3 Mbps to 6 Mbps	3 Mbps to 6 Mbps
Tier 4	6 Mbps to 10 Mbps	6 Mbps to 10 Mbps
Tier 5	10 Mbps to 25 Mbps	10 Mbps to 25 Mbps
Tier 6	25 Mbps to 100 Mbps	25 Mbps to 100 Mbps
Tier 7	> 100 Mbps	> 100 Mbps

Table 1: FCC Speed Tiers

Until very recently, the FCC defined broadband as 4 Mbps downstream and 1mbps upstream. As shown in the table above, that standard translates to a minimum Tier 3 download and Tier 1 upload connection to qualify as broadband service. In July of 2014, the FCC announced that it planned to increase the download threshold to 25 mbps. On January 29th, 2015 the FCC formally redefined broadband as 25 mbps download and 3 mbps upload. This redefinition has the potential to dramatically increase the number of communities in the U.S. eligible for subsidy.

The rapid advancement of delivered data speeds in the U.S. caused the change in the definition of broadband. In 2000, only 4.4 percent of American households had a broadband connection (as defined prior to January 29, 2015) in their homes. By 2010, that number had jumped to 68 percent. Moreover, since 2010, average delivered speeds in the U.S. have doubled overall, and today roughly 94 percent of Americans have access to wireline or wireless broadband speeds of at least 10 Mbps downstream. As a result, the FCC raised the minimum threshold.[3] This evolving baseline reflects a growing need for higher

[2] 1 Gbps = 1000 Mbps = 1,000,000 Kbps.

[3] Pg. 4. *Four Years of Broadband Growth*, June 2013. The White House Office of Science and Technology Policy & The National Economic Council. http://www.fcc.gov/document/fcc-finds-us-broadband-deployment-not-keeping-pace

bandwidth as Americans increasingly use the internet and communications technologies in all aspects of their lives.

In terms of functionality, the following table shows download speeds[4] required for a range of common internet-based activities:

	Basic Use (Email, Web Surfing Basic Video)	Moderate Use (Basic use plus high demand functions i.e. gaming, conferencing, HD video)	Heavy Use (Basic use plus multiple high demand functions)
1 user on 1 device (laptop, tablet, gaming console)	1 – 2mbps	1 – 2mbps	6 – 15 mbps
2 users on 2 devices at a time	1 – 2mbps	1 – 2mbps	6 – 15 mbps
3 users on 3 devices at a time	1 – 2mbps	2 – 5 mbps	15 mbps or more
3 users on devices at a time	2 – 5 mbps	6 – 15 mbps	15 mbps or more

Figure 1: Minimum Download Speed for Common Activities

Download and upload speeds depend on the type of communications technology service providers utilize. There are a number of different technologies currently available to residential and business users, which offer varying bandwidth capabilities:[5]

[4] FCC, Household Broadband Guide.

[5] Pg. 5. The ConnectME Authority. 2012. *Developing Broadband in Maine: Strategic Plan.* Available at http://www.maine.gov/connectme/grants/ntia/planning.shtml.

Technology	Download & Upload Speeds
Dial-up	Up to 56 Kbps
2G Mobile	Up to 100 Kbps
3G Mobile	384 Kbps – 2 Mbps
4G Mobile[6]	2 Mbps – 18 Mbps
Satellite[7]	200 Kbps – 2 Mbps
DSL	768 Kbps – 7 Mbps
Traditional Cable	1 Mbps – 10 Mbps
DOCSIS 3.0 Cable	1 Mbps – 150 Mbps
Fixed Wireless[8]	1 Mbps – 1.5 Gbps
T-1	1.5 Mbps
Fiber Optic	Up to 1,000 Gbps. Effectively infinite

Table 2: Technological Speed Capabilities

The speeds shown above are averages achieved for each technology. Higher speeds are possible for certain technologies depending on network layout and user saturation. If a user is located close to a network node, which houses the networking equipment that sends the network signal, and overall network use at that point in time is low, he will obtain higher connection speeds. DSL subscribers commonly experience this phenomenon. If a DSL subscriber is located close to the service provider's (Verizon for example) remote terminals he can achieve download speeds as high as 15 Mbps.[8] However, as one moves farther away from the remote terminal, download and upload speeds decrease. Outside of one mile from a central office, it is very difficult to achieve a broadband connection over DSL.

[6] AT&T Wireless currently has the highest tested capacity at 18 Mbps.

[7] Current satellite service may achieve broadband level speeds, but the excessive latency or delay precludes the use of many broadband applications.

[8] The Rhode Island company Towerstream offers up to 1.5Gbps.

Block Island's Broadband Standard

The Town of New Shoreham's town manager, public employees, and broadband committee described a desire for universal access to symmetrical high speed broadband that will serve the needs to the community for years and for generations. These needs consist of two goals. First, supporting the year round community's civic, educational, and business activities. Second, improving the seasonal community's ability to work and communicate while on island.

Many of the year round residents cannot access sufficient broadband speeds to video conference, participate in online learning opportunities, or run businesses from the island. Some residents report switching to expensive satellite broadband just to meet their day to day needs. These satellite services provide connections roughly equivalent to well-functioning DSL but at three to five times the cost. For this reason, the Town government and the state of Rhode Island commissioned this study to assess the options for meeting this standard. A FTTP solution can easily achieve these speeds while also allowing residents to increase their service to one gbps one higher. Note that this study does not contemplate phone or video service.

New Shoreham attracts many summer visitors. The community hopes that greater bandwidth will help some seasonal residents work from their Block Island homes, thereby increasing their stay and local economic impact. Furthermore, day trippers comprise a major share of the economic activity on the island. The Town's population can grow to as many as 20,000 people on busy weekends in the summer months. This strains the island's cellular infrastructure, which was designed to serve approximately 1000 residents. The Town has expressed interest in improving the experience of these visitors to the island through improved access to wireless data. While this goal is secondary to the primary goal of serving residents and business, serving as a desirable recreation destination is central to the Town's identity.

Goal One – Improved Residential and Business Broadband

Telecom Asset Inventory

After articulating the broadband standard, the team identified the telecommunications assets on Block Island. Currently, no fiber optic cable connects the Island to the mainland. No fiber optic cables were observed during the telecom asset inventory. The internet service options on the island consist of Verizon New England DSL, Verizon Wireless mobile hot spots, AT&T wireless mobile hot spots, and satellite service broadband offerings. The wireless and wireline communications on island utilize microwave connections for backhaul. Verizon New England provides municipal buildings including the school, town hall, and health center with T-1 copper connections. This provides superior bandwidth to DSL but it does not meet the standard.

The island has two towers that appear to provide cellular service to the island. The Verizon-owned tower is the point at which phone and DSL internet user's data downloads and uploads are transmitted to the internet via microwave. Most towers on the mainland utilize fiber optic cables for their backhaul needs. The locations of the microwave backhaul sites and the cellular antennas on the Verizon tower are shown in the figure below.

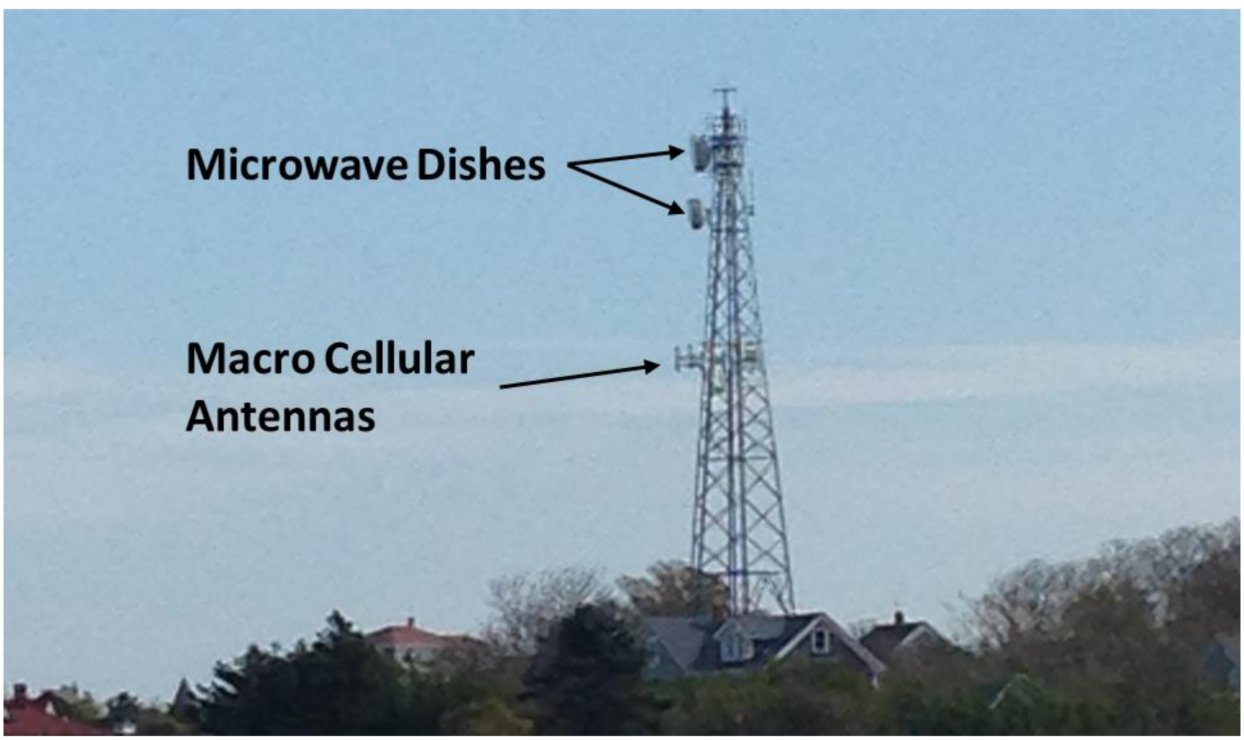

Figure 2: Verizon Tower

The Block Island Power Company tower holds three arrays of cellular panel antennas serving the island. Two of these are 4G LTE or 3G arrays. Analysis of carrier service areas suggests that these belong to Verizon Wireless and AT&T. Sprint also claims to serve the island with 3G data. There appears to be an additional voice array on the tower as well. Subscribers to other carriers may receive service on the island through roaming agreements with these carriers. As with wireline voice and data service, connection to the internet is provided via microwave arrays. The figure below shows the respective locations of this equipment on the tower. Reports from the Power Company indicate that this tower is fully occupied and that there is no space for additional deployments. Visual inspection corroborates this statement.

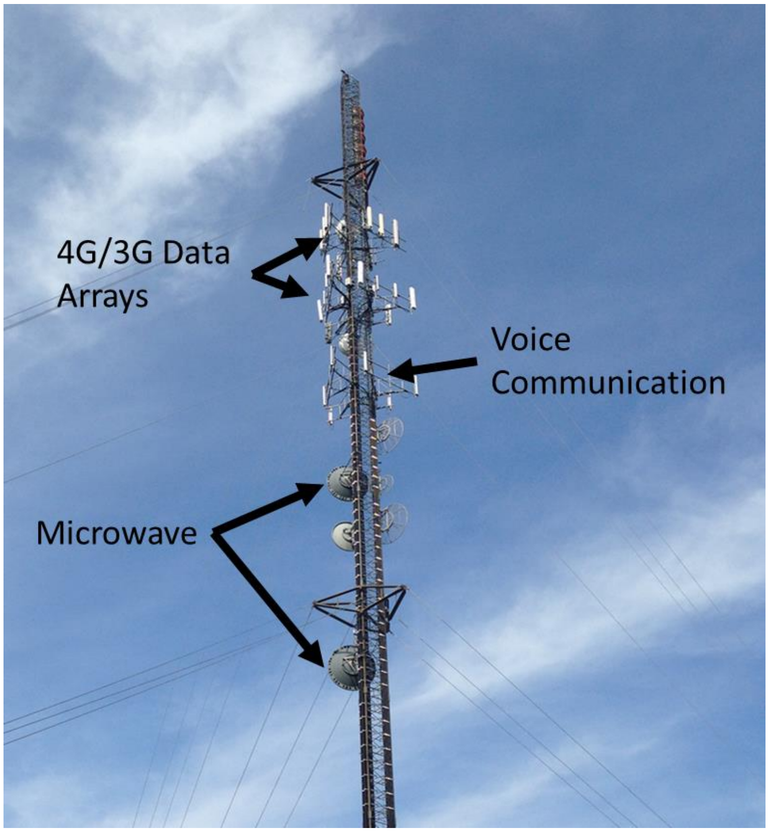

Figure 3: Block Island Power Company Tower

The FCC tracks all towers utilized for cellular communications. The table below gives the FCC data on both these towers as well as a deconstructed tower that once belonged to Astro Telecommunications Corporation, which has gone out of business.

Registration Number	Status	Owner Name	Latitude/ Longitude	Overall Height Above Ground (AGL)
1049679	Constructed	Block Island Power Company	41-10-28.0N 071-34-18.0W	76.5
1204467	Dismantled	Astro-Telecommunications Corp.	41-10-30.4N 071-34-08.2W	51.0
1211820	Constructed	Verizon New England	41-10-21.3N 071-33-50.1W	50.9

Table 3: FCC Tower Data for Block Island

In addition to the two cellular communications towers, there is a 40 foot tower at the police station and at least two private large radio antennas on the island. The police station tower appears to be used for two way public safety radio traffic. The private radio antennas stand approximately 20 feet tall and are similar in appearance to structures used to track migratory birds along the east coast.[9] It is likely that these antennas serve a research purpose.

Figure 4: Private Research Antenna

The figure below shows the locations of these tower assets as well as the approximate cellular data coverage on the island. Significant coverage gaps exist at the northern and south eastern ends of the islands. Note that cellular data signals degrade over water due to reflection. So it is unlikely that islanders will receive service from the mainland.

[9] http://scienceandnatureforapie.com/an-antenna-on-napatree-what-is-this-neighborhood-coming-to/

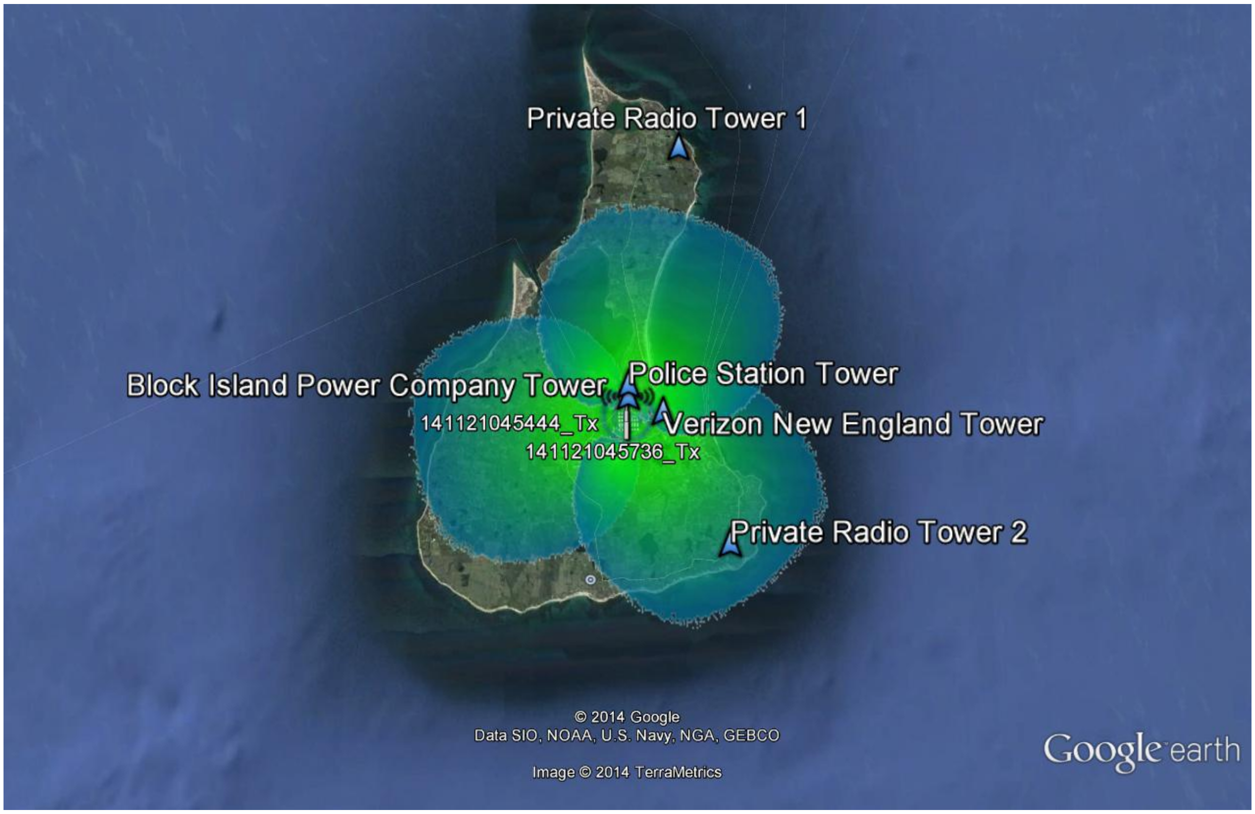

Figure 5: Tower Locations and Cellular Coverage on Block Island

New Shoreham is the only town in Rhode Island without a cable provider. This is significant because most residential customers in the U.S. purchase their high-speed broadband service from cable companies like Comcast, Cox Communications, and Time Warner Cable. New Shoreham residents are a step behind the rest of the country in this regard. Businesses are similarly disadvantaged. Even if a hotel or restaurant owner wanted to purchase a high speed broadband connection, the service is not available to buy on the island. The Block Island Cable Company used to provide service to the island but shut down several years ago. The loss of the cable company did, however, leave open space on the utility poles for stringing fiber optic cable.

The offshore wind developer, Deepwater, proposes to connect their development with Block Island and the mainland via submarine transmission cable. In exchange for easements to public land, the cable owner, National Grid, has offered the Town a lease of four to eight strands of fiber (the final number is still under negotiation) for the lifespan of the cable. Although this is not yet built, it represents an important piece of telecommunications infrastructure that should become available in the short to midterm. The cable will allow the Block Island Power Company to purchase wholesale electricity from the grid and retire the diesel generators that currently provide the island's power. After including a diesel surcharge, Block Island residents currently pay four times higher retail electric rates than mainland Rhode Island. The proposed cable will make landfall at Fred Benson Town Beach. It will be buried and unnoticeable. It will then follow Corn Neck Road south, turning right on Beach Avenue, and then left on Ocean Avenue before terminating at the power company's location. The map below illustrates this route and an extension to the Town hall, which is also under discussion. The Town can splice into this cable at any place along the route and construct a lateral to a head end location. The head end location represents the point of demarcation from a National Grid owned asset to a Town-owned asset. From this point, the Town can operate one of the proposed networks.

Figure 6: National Grid Fiber Route

It must be reemphasized that even if this fiber is not built, the Town can still proceed with one of the network builds and utilize redundant 10 gigabit microwave links for connection to the internet, which would provide adequate backhaul service. There are options for connecting to the mainland with or without this fiber.

Network Design – Fiber to the Premise

The Town of Block Island can provide universal fiber to the premise service for an estimated capital cost of $4.3 million. This includes all design, engineering, make ready costs, splicing, equipment, and traffic control costs associated with construction. The figure below shows the major fiber routes necessary to serve every home on the island. All of the Town fiber originates from the head end location, which this design contemplates as the police station. Backbone cables with 288 fiber optic stands run from that location and split to a 144 count cable. These cables split further to 24 count cables that feed the multiport service terminals (MST). The MST is the point at which a residential or business customer connects to the network. Each MST has the capacity for twelve connections and this design cited the locations of 430 such devices.

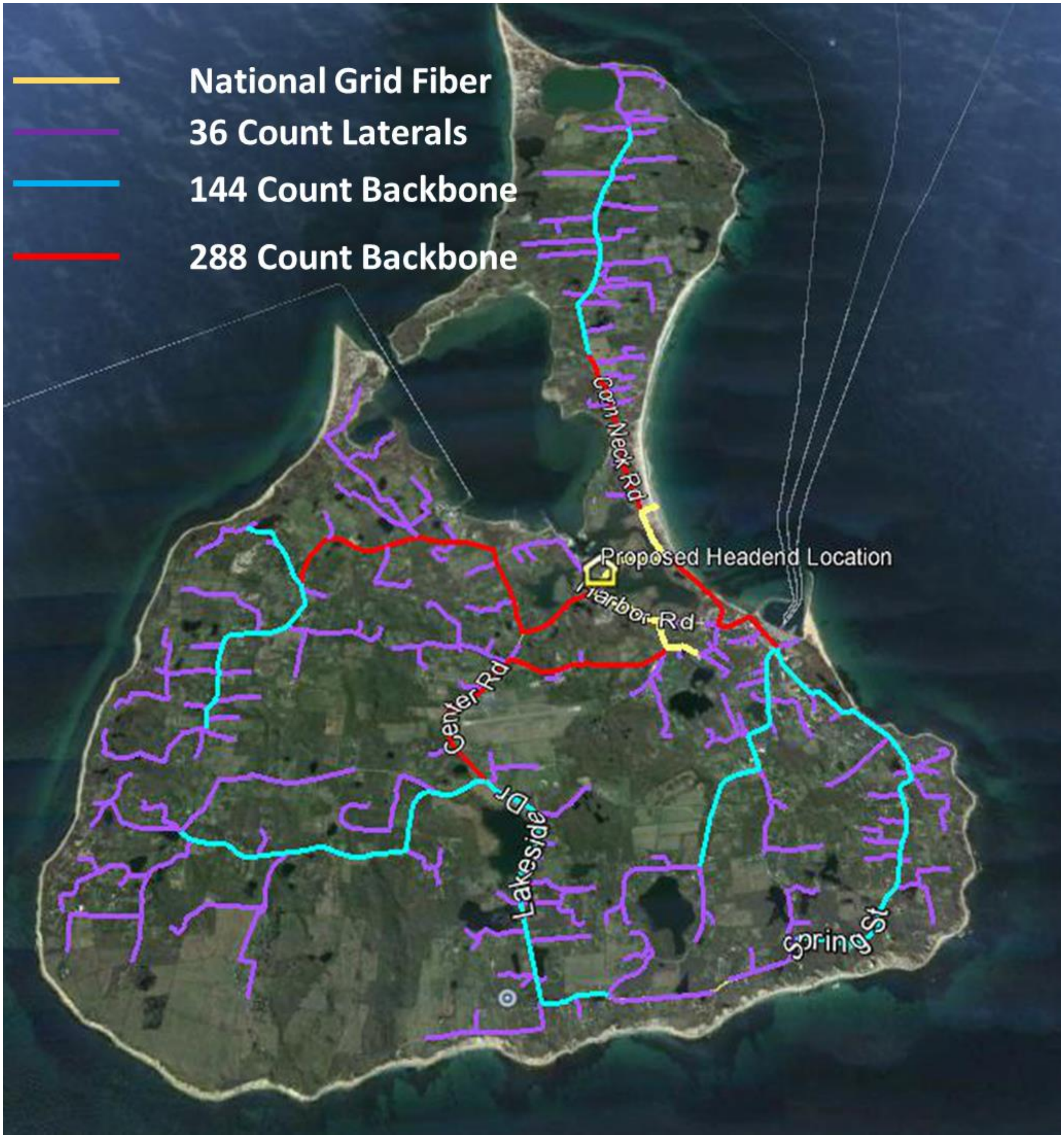

Figure 7: Block Island Fiber to the Home Design

The figure below shows a detailed view of the FTTP design for the northern extent of the island. The placemarks denote MST locations and the expected number of residential users at each location.

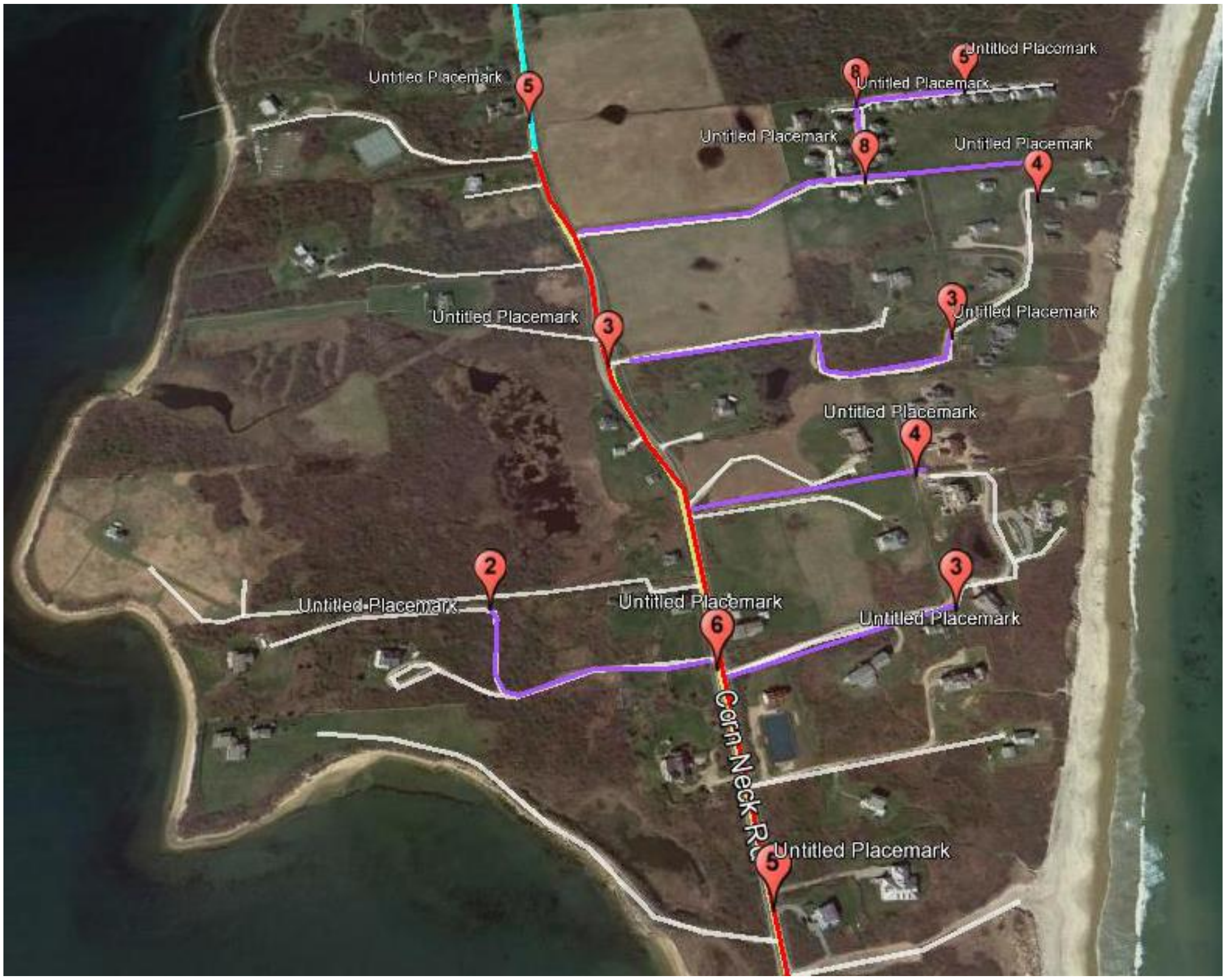

Figure 8: FTTH Design Detail

The FTTP design also connects the following community anchor institutions (CAIs) identified by the Town. Networking these facilities entails numerous benefits in addition to superior bandwidth. These facilities can share security feeds, pool internet usage, and share large GIS or research files seamlessly. If the Town elects to build the network with public funds, it can require the operator to provide dedicated service between these facilities and lite the circuits at little or no cost.

Rescue Barn	Town Hall
Sewer system	Dock Master
Police and Fire shared dispatch station	Library
K-12 School	North Light House
Block island medical center	University of RI Research Station
	Harbor Masters Office

Table 4: Community Anchor Institutions

Network Design – Hybrid Fiber Wireless

A less expensive alternative to the FTTP solution is wireless broadband. Wireless technology can achieve speeds in excess of the thresholds outlined in the standard. Under this option, wireless broadband would be delivered to homes and businesses using open or licensed spectrum. Due to the lack of available towers throughout most of the island, at least four new towers would need to be erected in order for this solution to be viable. A substantial backbone fiber optic cable connects these towers to the internet via the National Grid fiber or a microwave link. This design contemplates towers 75 feet tall, or about the same height as the Block Island Power Company tower. This is tall enough to rise above trees and other obstructions, but no so tall as to interfere with aviation. The design also includes two utility pole mounted small cell sites that provide service to the isthmus between the northern neck and the main body of the island.

Figure 9: Hybrid Fiber Wireless Solution Design

The towers are labeled by their compass direction. The pink areas represent the coverage of each tower. Note that each tower requires a substantial footprint. There are numerous potential sites that provide universal coverage to the island. The locations cited here illustrative and are not intended to reflect a commitment by landowners to lease property. Furthermore, this design does not consider any home ownership association, zoning, or other restrictions that might prohibit tower construction.

Head End Location

The key piece of infrastructure that transitions the national grid fiber to local fiber is a head end location. This can take one of two forms. One, a standalone shelter or two, a climate controlled and secure room in an existing building. The standalone shelter is a hardened, high reliability telecommunications building that can contain commercial telecommunications equipment for local distribution. This shelter is usually made of precast concrete, and includes battery backup, a generator, and climate control. A small fenced gravel compound contains the facility. An example of the standalone shelter is listed below.

Figure 10: Fiber Optic Head End Location

A headend facility installed in an existing building shares many of the same properties. The enclosure must be climate controlled with a generator back up and CO_2-based fire suppression systems. Water-based fire suppression systems are just as damaging to telecommunications gear as a fire.

This head end houses the equipment (optronics, switches, and cards) that allows the networked residences and business to connect to other networks, and the internet. This is the point at which the National Grid fiber would terminate and where the Towns' fiber would begin. If the Town were to utilize point-to-point microwave instead of fiber for backhaul, this would be the point where fiber running from the tower site would connect with fiber running to residential and business customers. Key characteristics of a good head end site include:

1) Isolated from flood
2) Road access
3) One pole distance to power lines
4) Within one quarter mile of the proposed fiber route.

There are several potential sites on the island. Should the Town chose to pursue a municipally owned network, the police station offers many desirable features. The site's 24 hour access, backup generator, elevation, and proximity to the currently contemplated National Grid fiber route make it highly advantageous place.

Business Model

Tilson envisions six potential business models for addressing the residential and business service gap on the island and meeting the broadband standard of universal 30 mbps+ symmetrical service.

1. The Town partners with the incumbent service provider, Verizon, to upgrade existing facilities on Block Island to serve all premises on the island at faster speeds. Verizon would construct, maintain, operate, and provide service on the network and would cover all ongoing operating costs. The Town would purchase bandwidth utilizing the National Grid fiber lease and resell that to Verizon at cost. Verizon would likely require some capital subsidy in order to build the network.

2. The Town partners with another existing commercial internet service provider, to build a fiber-to-the-home network on Block Island serving all premises on the island. The service provider would construct, maintain, operate, and provide service on the network and would cover all ongoing operating costs. This carrier would likely need some additional external investment to proceed.

3. A private community-oriented non-profit builds a fiber-to-the-home network to all premises on the island.[10] The entity would construct, maintain, and operate the network. The entity could partner with a private internet service provider to offer service to customers. The entity would own the network and be responsible for all ongoing operating costs, which would be paid using network revenues from customer subscriptions. The entity would be structured as a 501(c)3 and governed by a board of directors comprised of government employees, funders, and community stakeholders.

4. The Town pursues a joint venture with a private carrier to build a fiber-to-the-home network to all premises on the island. The venture would construct, maintain, and operate the network. The venture could partner with a private internet service provider to provide service to customers. The venture would own the network and be responsible for all ongoing operating costs, which would be paid using network revenues from customer subscriptions. This entity might be an LLC jointly owned by the Town and private investors from the community.

[10] By "community-oriented entity", we mean an entity consisting of individuals with personal or business connections to Block Island.

5. The Town builds a fiber-to-the-home network serving all premises on the island. The Town could partner with a private internet service provider to provide retail service to customers on a fee for service basis. The Town would own the network and be responsible for all ongoing operating costs, which would be paid using network revenues from customer subscriptions.

6. The Town builds a FTTH network to all premises on the island utilizing public funds (possibly from general obligation bonds). The Town leases the network to an internet service provider who operates, maintains, and provides internet service. The Town pays this operator on a cost plus fixed fee and bonus basis. Residual profits are held in a municipal escrow account to pay for future network upgrades and repairs.

The table below summarizes the business model options. It is advantageous to partner with a private carrier to utilize their poll attachment agreements. These agreements give them the right to secure fiber to utility poles and can be time consuming and/or expensive to secure. Also note, that Tilson recommends that the Town consult with municipal counsel before making conclusions regarding tax policy.

#	Who funds	Structure	Who owns facilities	Taxes	Who operates facilities	Who takes operating risk	Who gets revenue
1	Verizon and Town	Corporate ILEC	Verizon	Yes	Verizon	Verizon	Verizon
2	Private Carrier and Town	Corporate	Private Entity	Yes	Private Entity	Private Entity	Private Entity
3	Town and Non-Profit	501(c)3 or equivalent	Non-Profit	No	Contractor	Private Entity	Town after non-profit and contractor costs
4	Town and Private Carrier	Public Private Partnership (e.g. LLC or S-Corp)	PPP	Maybe	Private Carrier	Private Carrier	Private Carrier
5	Town	Municipal	Town	No	Contractor	Town	Town
6	Town	Capital Lease	Town	Maybe	Private Carrier	**Either** Private Carrier **or** Town	Revenue share commensurate with risk

Capital Cost Estimate

Fiber to the Premise Network

In this FTTP design 20% of the route will be buried cable with the remaining 80% deployed aerially. This swells the costs significantly because trenched construction is six times more expensive than aerial construction. Reducing the buried cable proportion to 10% would save $675,000 in capital costs. Trenched construction is a method of burying fiber where the ground layer is opened up and a fiber cable is laid in the gap. By contrast, directional boring is a method whereby fiber is deployed horizontally without breaking the surface. This is twice as expensive as trenching. Tilson believes that the 20% trenching estimate may be high. Network deployments tend to favor aerial construction whenever possible, due to the schedule and cost advantages. The only reason to bury fiber is when aerial deployment is unavailable.

Fiber Cable (all counts)	$214,775
Aerial Construction	$706,244
Under Ground Construction	$1,583,700
Splicing	$278,232
Make Ready	$267,110
Professional Services	$325,006
Contingency	$371,257
Customer Installation (Year 1)	$577,125
Total	**$4,323,449**

Table 5: FTTH Capital Costs

Notably, the actual cost of the fiber only represents five percent of the total capital costs. Make ready represents the costs associated with the movement of other cables on utility poles. Usually, a new network builder is required to pay the costs of moving existing equipment. However, the removal of the Block Island Cable Company's equipment likely creates an opening for the fiber deployment without significant make ready costs. Therefore this make ready estimate is likely conservative. Professional services include engineering and legal fees associated with the network build. The customer installation costs represents the cost of installing the equipment on a customer's home necessary to transmit and receive signal over fiber optic cable. Tilson estimated that 50% of households would sign up for the service in the first year. The Town can decided whether this cost is part of the capital cost or the responsibility of the customer.

Hybrid Fiber – Wireless Network

New tower construction will be necessary in order to serve all of the areas of the Island. The current tower infrastructure is consolidated in one area. Therefore, this solution's implementation requires the construction of at least four 75 foot towers in the island's four quadrants. The actual costs of engineering and erecting towers is the largest share of the capital costs.

Fiber Backbone	$227,449
Tower Construction	$636,000
Small Cell Construction	$67,000
Professional Services	$113,045
Contingency	$104,349
Customer Site Installation	$252,000
Total Capital Costs	**$1,399,844**

Table 6: Hybrid Fiber - Wireless Network Capital Costs

Wireless network capital cost partially depends upon subscribership. The more people sign up, the higher the net installation costs. Tilson estimates the total cost of installing a wireless receiver and mount to be $280 per premise. If 80% of Block Island's 1800 residential buildings subscribed to the service, the total cost of installation would be $403,200. If the Town proceeds with this option, it will need to decide if equipment costs are included in the capital costs of the network. Note that this capital cost estimate does not account for the cost of acquiring land on which to build.

Operating Cost Estimate

Fiber to the Premise Network

Tilson estimates that the total costs for operating the network will range between $355,000 and $652,000. They are shown in the table below.

Operating Expenses	Low	Best	High
Pole Attachment Fees	$30,000	$39,000	$48,000
Maintenance & Repair	$45,000	$67,500	$90,000
Bandwidth	$72,000	$90,000	$108,000
Fixed G&A	$89,250	$119,000	$148,750
Variable G&A	$118,800	$198,000	$257,400
Total	**$355,050**	**$513,500**	**$652,150**

Table 7: FTTH Operating Costs

Pole attachment fees are essentially rent paid to the pole owners, Verizon New England or Block Island Power Company. Tilson estimated 50 poles per mile of road and mapping showed there to be 60 miles of roads on the islands. Fees typically range between $10 and $16 per pole depending on the utility. These costs may be mitigated by burying cable for some customer drops, although the capital costs are higher. Maintenance and repair represent the ongoing costs of maintaining the network. These typically range between 1.5% and 3% of the total capital costs. Bandwidth represents the costs of wholesale data. This is necessary to connect the island network to the internet. Networks of this size typically require between two and three gbps of bandwidth. Tilson assumed a price of $3.0 per mbps, which is based on a recent quote. Fixed general and administrative costs include items such as electricity, rent, technician wages, and legal expenses. Once the final network design and business model are selected, these costs tend to remain fairly constant. Variable general and administrative costs scale with customer sign ups. Every internet customer costs their ISP approximately $220 per year in service time, billing, and other administrative expenses.

Hybrid Fiber – Wireless Network

Tilson estimates that the operating costs for the hybrid fiber-wireless network to be in line with those of the fiber to the premise network. Pole attachment fees and maintenance are significantly less expensive for this network for reasons of scale. This solution utilizes one sixth as many poles as the FTTP solution. The lower capital costs also drive maintenance costs lower, as maintenance is calculated as a percentage of total capital expenditure. However towers require more maintenance than fiber, so the percentage ranges from 3% to 5%. The remaining costs are the same for this solution.

Operating expenses	Low	Best	High
Pole Attachment Fees	$5,000	$6,500	$8,000
Maintenance & Repair	$27,913	$37,218	$46,522
Bandwidth	$72,000	$90,000	$108,000
Fixed G&A	$89,250	$119,000	$148,750
Variable G&A	$118,800	$198,000	$257,400
Total	**$312,963**	**$450,718**	**$568,672**

Table 8: Wireless Operating Costs

In addition to these operating costs, Tilson recommends an intensive customer service exercise for several months following network go live. Wireless broadband is a new technology to many users. Maintaining a customer service technician on site for real time service visits can help build customer satisfaction and ensure long term network viability. This would consist of two technicians residing on Island for a period of four months and responding to, and resolving, every service request.

Customer Service Costs	
Labor	$153,600
Travel Costs	$3,600
Accommodations	$9,600
Per-diem	$16,800
Total Customer Service Costs	$183,600

Table 9: Customer Service Costs

Network Concept – Hybrid Fiber Coaxial Cable

Another option for improving broadband on Block Island at little to no risk to the Town would be to incentivize a company such as Comcast, Time Warner, or Cox Communications to provide their normal suite of internet, television, and phone services on the island. Comcast provides service on both Martha's Vineyard and Nantucket. If the new fiber optic cable is available to provide backhaul, a cable provider may be interested in establishing service on island for low or no capital investment from the town.

The hybrid fiber coaxial cable technology that cable companies utilize costs approximately $45,000 per mile to build on the mainland. Assuming an island premium of 15% and 60 road miles on Block Island, this yields a total capital cost estimate to the company of $3.1 million. Some cable providers may seek a capital subsidy to build their network. The broadband technology used by cable companies does not meet the standard described by the Town. However, it is capable of providing speeds up to 30 mbps and also includes service offerings that an ISP cannot provide, such as video (television). Tilson recommends that the town consider this option as a potential third solution.

Goal Two: Improved Wireless Service

As a summer colony situated between Boston and New York, Block Island sees many seasonal visitors. The Town estimates that the population can swell from 1000 to over 20,000 on busy weekends from June through August. Many of these visitors carry multiple internet enabled devices. User reports suggest that the Town's single cellular tower cannot provide robust signal to all of these users during these peak periods. Tilson recommends that that the town take the following steps to support improved cellular service.

1) Facilitate Zoning and Permitting Approval for Cellular Carriers

The major cellular carriers have historically utilized antennas mounted on towers for providing data service to data-enabled devices. Over the next several years, Tilson expects these carriers to shift their capital investments from building these macro sites to installing more discrete microsites. This new technology provides the same 4G LTE service but is much smaller and can be mounted on a building corner or telephone pole. Deployed in sufficient density, these can provide a large group of users low latency data service where a larger site would have been overloaded. Verizon Wireless has expressed an interest in securing lease agreements to the utility poles on Block Island. The more streamlined the zoning process, the more likely Block Island is to see improved cellular service in the near future.

2) Make Fiber Available to Cellular Providers

Assuming the Town elects to proceed with one of the Tilson proposed solutions, fiber will be deployed throughout the island. This fiber will be essential for connecting any cellular site to the internet. Keeping the network available to carriers on an open access or wholesale basis, allows them to meet their backhaul needs without going through their own fiber build. This reduces their costs of providing service tremendously.

3) Provide a WiFi Solution

The easiest solution for the Town to improve data coverage is to provide free WiFi to the downtown area and possibly the beaches. Smart phones and tablets could utilize this network in the event that the cellular data networks become oversaturated. The tower assets described in the hybrid wireless-fiber design could also be utilized for this purpose.

Economic Impact of Block Island Network

Research has shown that investments in broadband infrastructure can dramatically improve economic development in rural communities. Broadband enhances productivity, makes firms more efficient, facilitates commerce, attracts jobs, increases consumer options, and saves residents money.

The economy of coastal Rhode Island and Massachusetts has contracted in real terms over the past ten years. According to the US Bureau of Economic Analysis, the region experienced a net average annual real GDP decrease of 0.34% between 2003 and 2013. The US economy as a whole, by contrast, grew at an average annual rate of 1.6% over the same period.[11] Without conducting an extensive survey of spending trends on island over the past ten years, it is impossible to precisely estimate the economic product of Block Island alone. Therefore, Tilson used the economic data of Barnstable County as a corollary. Barnstable County shares many of the same characteristics of Block Island. Tourism constitutes a large component of economic activity and the region is home to many seasonal residents.

Tilson used "value transfer method" to conduct this analysis. This consists of borrowing the research contained in peer reviewed studies of the economic impact of broadband and applying local data to the same models. Tilson first gathered census data for Block Island and Bureau of Economic Analysis data for Barnstable County to establish the economic baseline. Then the team ran those estimates through economic models that forecast the impact of new broadband infrastructure on increasing gross domestic product (GDP), creating jobs, and enhancing consumer well-being on Block Island. Tilson believes developing universally-available, world class broadband infrastructure on the island has the potential to increase GDP growth to 3.7% by 2019.

This estimate represents $23.7 million in additional goods and services sold on the island over ten years. This figure is open to debate. However, a large increase in broadband penetration usually results in a significant increase in output. In a study of 22 Organization for Economic Cooperation and Development (OECD) member countries, Koutroumpis et al. (2009) found that an increase in broadband penetration of 10 percent added 0.25 percent to GDP growth on average.[12] In a similar study, Czernich et al. (2009) found that an increase in broadband penetration of 10 percent added 0.73 percent to GDP growth on average.[13]

A pertinent case study in the U.S. is Lake County, Florida. A rural area north of Orlando, the county saw its economic output double relative to its neighboring counties within five years of a major broadband build out to the county's community anchor institutions (Ford and Koutsky, 2005).[14] Therefore, Tilson believes that its estimate for Block Island may be conservative. As shown in the figure below, the positive impact of broadband development on Block Island's economy compounds year after year while

[11] U.S. Bureau of Economic Analysis, 2014. These values account for inflation by keeping all figures in 2009 dollars.

[12] Koutroumpis, P. 2009. The economic impact of broadband on growth: A simultaneous approach. *Telecommunications Policy*. Vol:33, Pages: 471-485.

[13] Czernich, N., Falck, O., Kretschmer, T. & Woessman, L. 2009. Broadband Infrastructure and Economic Growth. *The Economic Journal.* Vol: 121, Pages: 505-532.

[14] Ford, G. and Koutsky, T. 2005. Broadband and Economic Development: A Municipal Case Study from Florida. *Review of Urban & Regional Development Studies. Vol: 17, Pages: 219-229.*

there is fixed upfront cost to deploy the network. The additional capital costs after year one represent new customer sign ups.

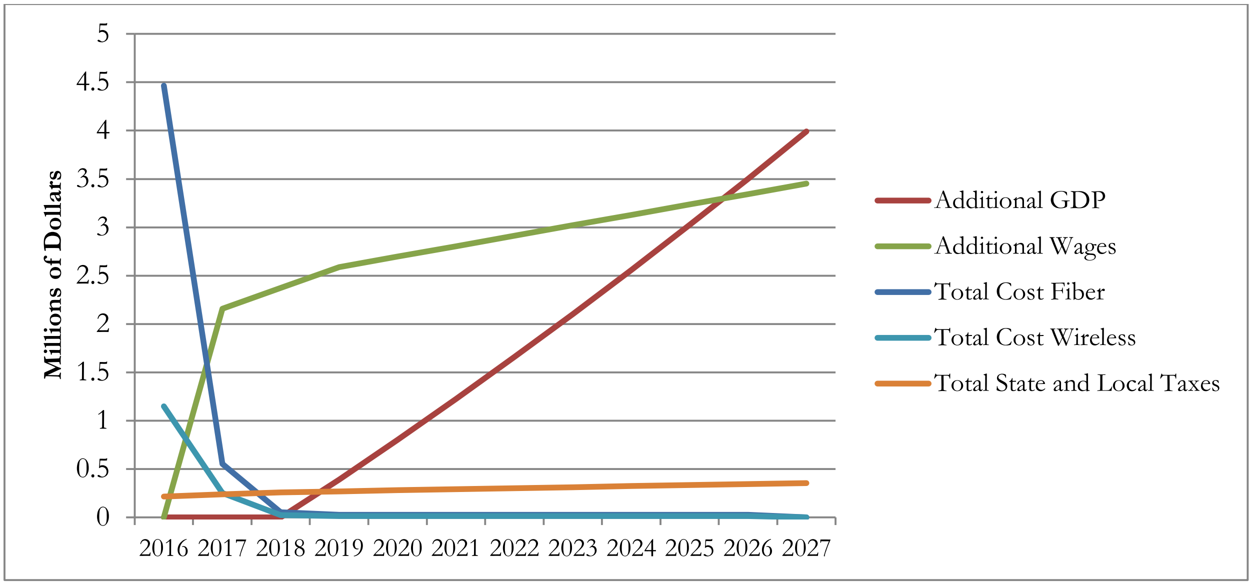

Figure 11: GDP, Wage, and Tax Impact of Broadband Investment

In addition to increasing local GDP, broadband development also creates jobs. Unlike economic output, which typically takes at least two years for communities to begin reaping the full effects of an investment, job creation occurs immediately. Broadband investments affect employment in three ways.

- Direct Jobs (telecommunications technicians, construction workers, and manufacturers of telecom equipment)
- Indirect Jobs (upstream suppliers and sellers of raw materials)
- Induced Jobs (from the household spending resulting from the new direct and indirect jobs)

These jobs tend to be higher paying, technology-oriented jobs, some of which are temporary but many are stable and more or less permanent improvements to the region's economy. A study of broadband development in rural Kentucky found that every 1 percent increase in broadband adoption yielded a 0.14 percent increase in employment (Shideler et al. 2007).[15] This factor suggests that 45 new jobs will be created in on the Island by 2027 under one of the solutions considered. Assuming these jobs pay Barnstable County's median wage, Tilson estimates approximately $3.5 million in state and local tax revenue will be generated over the next ten years.

Lastly, broadband investments improve consumer wellbeing. Consumers are not necessarily better off just because economic output increases. An increase in GDP just means that they are spending more. That being said, broadband access empowers consumers to both pay less for goods than they otherwise would have purchased and to purchase goods and services that were not available before. For example, broadband allows consumers to enjoy almost limitless video content for little or no cost. Without it,

[15] Shideler, D., Badasyan, N. & Taylor, L. 2007.The Economic Impact of Broadband Deployment in Kentucky. *Regional Economic Development*. Vol: *3*, Pages: 88-118.

consumers pay more to rent films and or subscribe to satellite television. In economic lexicon this phenomenon is known as “consumer surplus”.

For the purposes of this exercise, consumer surplus is defined as the amount that consumers benefit from purchasing a product for a price that is less than what they would be willing to pay. In a study of 40 million U.S. households with access to broadband, Greenstein and McDevitt (2009) found that broadband access increased consumer surplus by between $120 and $167.50 per household, per year.[16] Tilson’s economic analysis assumes that year-round Block Island residents would enjoy this full benefit, while seasonal residents would enjoy 30 percent of consumer surplus benefit. This translates to a total increase in surplus of between $885,000 and $1,235,000.

Overall, Tilson believes that investment in broadband on Block Island would be a strong contributor to economic development in the community that offers a range of public benefits. Improving broadband access would supplement Block Island’s traditional economic activities, while also supporting conditions for new enterprises. Due to these added public benefits, Tilson recommends that investment in broadband infrastructure is considered not only through a lens of the network’s profitability, but also as a long-term investment in the sustainability of the community and economic development on the island.

[16] Greenstein, S. and McDevitt, R. 2009. The Broadband Bonus: Accounting for Broadband Internet Impact on U.S. GDP. NBER Working Paper No. 14758.

Conclusion

The Block Island community has several options available for improving broadband service. The Fiber to the Premise solution has the potential to provide a generation of world class broadband service. The hybrid fiber-wireless option can provide excellent broadband at a lower capital cost. However, the new tower assets have the potential benefit of improving cellular communications on the island in addition to providing broadband service. While the fiber network offers superior service, the cellular network offers lower capital costs. It is also worth noting that the antiquated state of Block Island's telecommunications infrastructure may make the community eligible for federal subsidy to offset some of the capital costs of the construction.

As the Town continues to contemplate its broadband future it will face several decision points. In the short term, Tilson recommends that the Town contemplate the following next steps.

1) Finalizing negotiations with National Grid to define the Town's right of use to the fiber optics. Four or eight strands can meet any network backhaul needs. The most important outcome from the negotiations is ensuring unrestricted access. Even if the fiber does not become available, the island can utilize microwave links for backhaul.
2) Determine Town preferences. Tilson recommends that the Town circulate the findings of this report with the broadband committee and determine preferences among the three solutions and six business models presented.
3) Issue a request for information to the service provider community. The Town can invite service providers to describe their approach to bridging Block Island's service gap. Their solution description can include technical approach (fiber, wireless, coaxial), experience, pricing structure, and business model. The results of this solicitation can provide the Town with an actionable proposal from a vendor to fill the identified broadband gap.